

IV. "Intensity of Radiation through Turbid Media." By Captain ABNEY, R.E., F.R.S., and Major-General FESTING, R.E. Received May 3, 1886.

In the Bakerian Lecture for this year, which was delivered before the Royal Society on March 4th, on Colour Photometry, we gave incidentally the results of some measurements we had made of the intensity of visible radiation which penetrated through a transparent medium as compared with that which penetrated through the same medium rendered turbid. We showed that the formula deduced by Lord Rayleigh from the scattering of light by small particles* was confirmed by our experiments. We thought, however, that the theory might be more fully tested if a larger range of spectrum than that to which we had confined ourselves were used, and at the same time it would be more satisfactory if an instrument possessing no personal equation could be utilised. Our thoughts naturally turned to the thermopile, and more particularly to that form which we described in a previous communication to the Royal Society ("Proc. Roy. Soc.," vol. 37, p. 157, 1884), since its delicacy was extremely great. In the Bakerian Lecture the results we gave were obtained from water rendered turbid, and it appeared to us that the same medium would again answer our purpose—more especially if certain precautions were taken. It will be in the recollection of the Society that we have shown that water possesses very definite absorption-bands in the infra-red of the spectrum ("Proc. Roy. Soc.," vol. 35, p. 328, 1883), as also does alcohol. Now, as the turbidity of the water we desired to produce was made by adding a dilute solution of mastic dissolved in alcohol to the water, it was evident that in addition to the water-spectrum we should also have superposed a faint alcohol spectrum, if the addition of the latter was made in any quantity. Had the spectrum of a definite thickness of pure and transparent water been compared with one of the same thickness of water rendered turbid by the mastic, it is evident that a discrepancy might have arisen owing to alcohol being present in the one case and not in the other. To avoid this difficulty, when great turbidity was to be produced, the amount of alcohol added with the mastic was measured, and the same quantity of pure alcohol added to the transparent water. By this plan the mixture of alcohol and water was the same in the two cases, the only difference in the two being that one had extremely fine particles of mastic suspended in it. A reference to our paper ("Proc. Roy. Soc.," vol. 35, p. 328, 1883) will show that a small thickness of water cuts off nearly all the spectrum

* "Phil. Mag.," vol. xli, p. 447, 1871.

below $\lambda 14,000$, and that $1\frac{3}{4}$ inches cuts off nearly everything below $\lambda 10,000$. It was therefore determined to use a thickness of $\frac{1}{2}$ inch, as up to $\lambda 14,000$ in that case the deflections of the galvanometer would be sufficiently large in both cases to allow the proportion of rays transmitted through the transparent and turbid media to be calculated without fear of any grave error due to inaccuracy of reading.

The spectroscope we have described was used for this purpose, and the source of light used was the crater of the positive pole of the electric light. The opening of the slit was about $\frac{1}{300}$ inch, and that of the linear pile about $\frac{1}{50}$ inch. In the first experiment we described the colour of the crater of the positive pole as seen after passing through the turbid medium was a lemon-yellow, and in the second a deep orange, nearly approaching red. It will be seen that theory and experiment agree within the limits that might be expected.

λ .	$\frac{1}{\lambda^4}$.	Thermopile readings.		Observed.	Calculated.*
		Turbid.	Clear.	$\frac{\text{Clear.}}{\text{Turbid.}}$	$\frac{\text{Clear.}}{\text{Turbid.}}$
<i>First Experiment.</i>					
524	14.03	3.25	14	4.31	4.20
558	10.60	6.5	20.5	3.15	3.15
609	7.72	12	29.5	2.47	2.42
652	5.29	20	38	1.90	1.91
684	4.58	27	48	1.77	1.77
720	3.72	38.5	63	1.63	1.63
762	2.97	45	68	1.51	1.50
813	2.29	54.5	77	1.41	1.41
877	1.68	64	85	1.33	1.33
960	1.18	58	73	1.26	1.26
1070	0.76	72	85	1.19	1.21
1170	0.53	39.5	45	1.14	1.12
<i>Second Experiment.</i>					
591	8.24	2	35	17.5	17.75
636	6.10	5	46.5	9.30	9.18
663	4.28	12.5	66	5.28	5.25
774	2.82	27.5	89	3.24	3.35
877	1.67	46	108	2.35	2.35
960	1.18	47.5	99	2.03	2.02
1040	0.855	55	101.5	1.84	1.83
1130	0.613	53	89	1.68	1.68
1230	0.437	28	48	1.60	1.62
1320	0.329	13	20	1.54	1.56

* These were calculated by the formula $I' = Ie^{-kx\lambda^{-4}}$, using the method of least squares.

Other measurements have been made, and which give results also in accordance with the theory.

It may be well to remark that in order to get a proper fineness of particle in suspension in the water, a very convenient plan is to add the varnish very gently and by very small quantities in a glass jar in which the water is automatically or otherwise stirred. The water should be of large volume to get the best results. To make the fineness still more uniform we have prepared the turbid medium as above, and then rotated the glass flask in which it was placed at the rate of about 2500 revolutions per minute. By this means any particles, except the very finest, are deposited on the sides of the flask, and the filtered liquid—if we may so call it—can be poured off ready for any experiments.

May 20, 1886.

Professor STOKES, D.C.L., President, in the Chair.

The presents received were laid on the table, and thanks ordered for them.

The following Papers were read:—

- I. "Relation of 'Transfer-resistance' to the Molecular Weight and Chemical Composition of Electrolytes." By G. GORE, LL.D., F.R.S. Received May 5, 1886.

(Abstract.)

In the full paper the author first describes the method he employed for measuring the "resistance," and then gives the numerical results of the measurements in the form of a series of tables.

He took a number of groups of chemically related acids and salts of considerable degrees of purity, all of them in the proportions of their equivalent weights, and dissolved in equal and sufficient quantities of water to form quite dilute solutions. The number of solutions was about seventy, and included those of hydriodic, hydrobromic, hydrochloric, hydrofluoric, nitric, and sulphuric acids; the iodides, bromides, chlorides, fluorides, hydrates, carbonates, nitrates, and sulphates of ammonium, caesium, rubidium, potassium, sodium, and lithium; the chlorides, hydrates, and nitrates of barium, strontium, and calcium; and a series of stronger solutions, of equivalent strength to each other, of the chlorides of hydrogen, ammonium,